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Statistical modelling of radio wave propagation under sporadic *E-Layer* influence

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Abstract

A technique of modelling the one-hop radio wave propagation at middle latitudes in the presence of sporadic *E-Layer* is presented. The technique is focused on the performance of the long-term forecast of the maximum usable frequency range and on the increase of the radio communication reliability. Examples of calculation for medium-distance paths are shown.

Keywords: Ionosphere; Radio wave propagation; Sporadic *E-Layer*; Peak electron densities; Global and regional maps

1. Introduction

Sporadic *E-Layer* has an essential influence on reliability and on communication quality. Sporadic *E-Layer* can provide radio communication on the frequencies exceeding the maximum usable frequencies (MUF) of regular ionosphere layers, and can also lead to serious degradation in communications blanketing overlying areas of the ionosphere (Kerblai and Nosova, 1997; Minullin, 1997; Miya et al., 1978; Bramley, 1972). Therefore, it is necessary to take into account its influence on propagation of HF and VHF radio waves. However, its influence is rarely considered when characteristics of the signals reflected from different layers of the ionosphere and scattered ionospheric irregularities are estimated. This can be explained by several reasons, including the probabilistic behaviour of frequency parameters of the layer, variation of its structure, and as a consequence, the variety in power and path characteristics of the reflected radio waves.

Research of the sporadic *E-Layer* influence on HF propagation was basically conducted on the radio paths using fixed working frequencies with the analysis of ionospheric state in the centre of the path to perform the selection of signals caused by the sporadic *E-Layer*. As a rule, the measurements were made on frequencies significantly greater than MUF of regular ionospheric layers (Kerblai and Nosova, 1997; Minullin, 1997). Miya et al. (1978) and Minullin (1997) have created the techniques for determination of probability characteristics of Es-signal on the fixed frequencies.

Fewer papers are devoted to investigation of sporadic *E-Layer* influence on mode structure of a received signal and its power characteristics (Sherstyukov et al., 2000). Sherstyukov et al. (2001) on the basis of researches on a 670 km Moscow-to-Kazan path by sweep frequency sounding revealed a three different frequency bands on which sporadic *E-Layer* affects a radio communication. First, the MUF range expands (is up from 0.5 to 1.5 MHz) due to sporadic *E-Layer* with the considerably increased electron density. Secondly, communication quality in the middle part of MUF range is degraded because of multipath propagation caused by sporadic E layer and regular ionospheric layer. Thirdly, communication quality improves in the bottom part of a range at disappearance of multipath propagation owing to Es-blanketing of the signals reflected from F2 layer.

In the present work the technique of modelling the radio wave propagation in the presence of sporadic *E-Layer* for

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